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RESEARCH ON NONLINEAR FILTERING ALGORITHMS FOR SATELLITE ATTITUDE ESTIMATION

Abstract

Filtering is one of the common signal processing methods in modern communication and control engineering. Aiming at the problem of high precision attitude estimation for three-axis stabilized satellite, by comparing various filtering algorithms for non-linear satellite attitude estimation, it is found that the Mean square error MSE of Sigma point set increases with the increase of system dimension when Unscented Kalman Filter(UKF) is carried out, which results in the estimation accuracy getting worse and worse, especially when the satellite attitude error angle appears larger deviation. In order to solve this problem, an improved UKF algorithm based on hypercube representative points is applied to satellite attitude estimation. The simulation results show that the improved UKF algorithm can achieve faster filtering convergence and better filtering accuracy than traditional filter algorithms, and effectively improve the attitude determination performance.

In the application of satellite attitude estimation, it is not enough to guarantee the mean and variance characteristics of the set of sampling points for the approximation of random vectors. Therefore, a criterion is needed to measure the approximation of the set of sampling points to the original distribution and to evaluate theoretically the representativeness of different sets of sampling points to the original distribution. The mean square error (MSE) criterion is a classical criterion to measure the uniformity of representative points in multivariate distribution.

It can be concluded that: 1) Replacing traditional Sigma points with hypercube representative points can significantly improve the representativeness of sampling points set to original distribution and greatly reduce MSE in high-dimensional state. 2) The traditional UKF has slow convergence, poor accuracy and easy divergence in filtering high-dimensional satellite attitude estimation model. The improved UKF can effectively accelerate the convergence speed, improve system accuracy and avoid divergence of filtering. It is more suitable for engineering applications.